The 21st Worldwide Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Exhibition

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Introduction to the U.S. Department of Energy's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

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Outline

- Project Overview
  - Objectives & key targets
  - Teams & plans
- Data Analysis
  - Data collection
  - Sample data analyses
- Conclusions

No confidential or proprietary data is contained in this presentation

Project Objectives and Targets

- Objectives
  - Validate "System" Solutions for H_2 Transportation
  - Identify Status of Technology
  - Re-Focus Research and Development
  - Support Industry Commercialization Decision by 2015

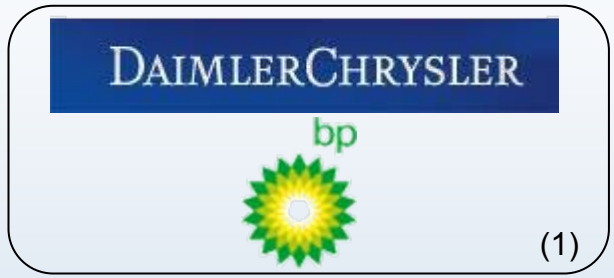
Hydrogen and gasoline station, WA DC

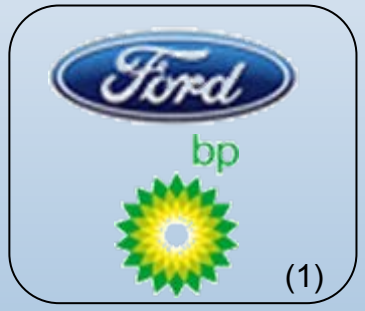
Key Targets

Performance Measure	2009*	2015**
Fuel Cell Stack Durability	2000 hours	5000 hours
Vehicle Range	250+ miles	300+ miles
Hydrogen Cost at Station	$3.00/gge	$1.50/gge

* To verify progress toward 2015 targets
** Subsequent projects to validate 2015 target

Successful Teams Announced

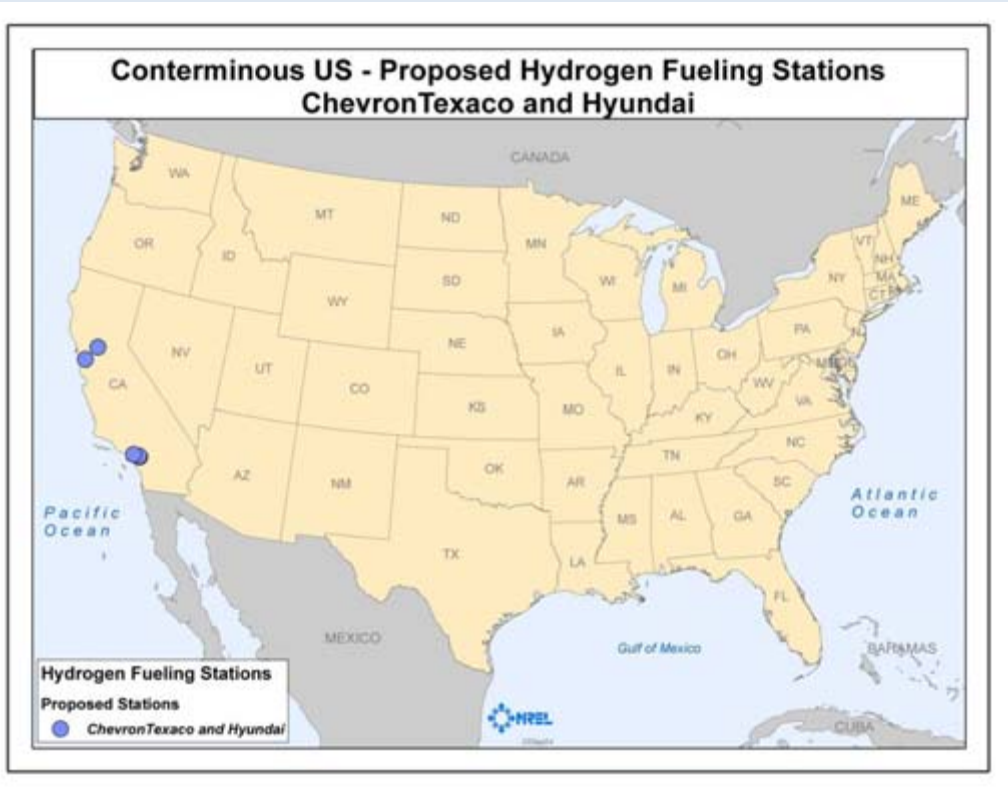




(1) Fuel cells supplied by Ballard

Team Overview – ChevronTexaco

ChevronTexaco
HYUNDAI
UTC Fuel Cells
A United Technologies Company

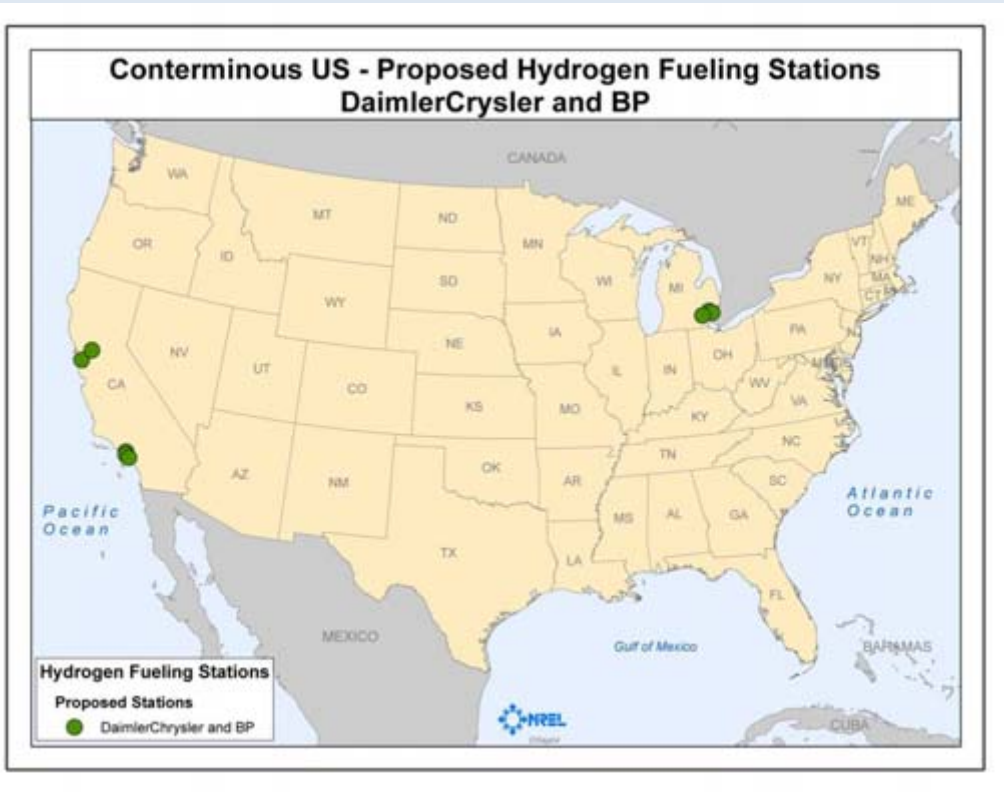


- 32 Fuel Cell Vehicles
  - -SUVs
  - -2 Fuel Cell Generations
- Up to 6 Fueling Stations
- 2 regions

Team Overview – DaimlerChrysler

DAIMLERCHRYSLER

bp

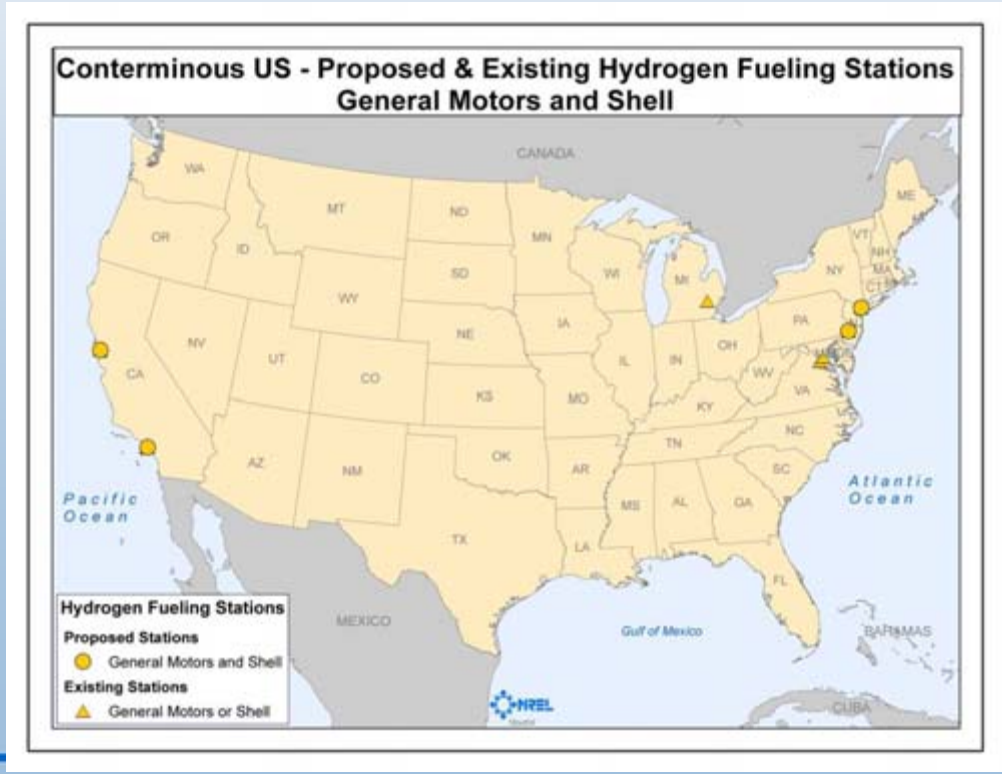


- 36 Fuel Cell Vehicles
  - -F-Cell Vehicles & Sprinter Vans (Gen 1)
  - -2 Fuel Cell Generations
- Up to 8 Fueling Stations
- 3 regions

Team Overview – Ford

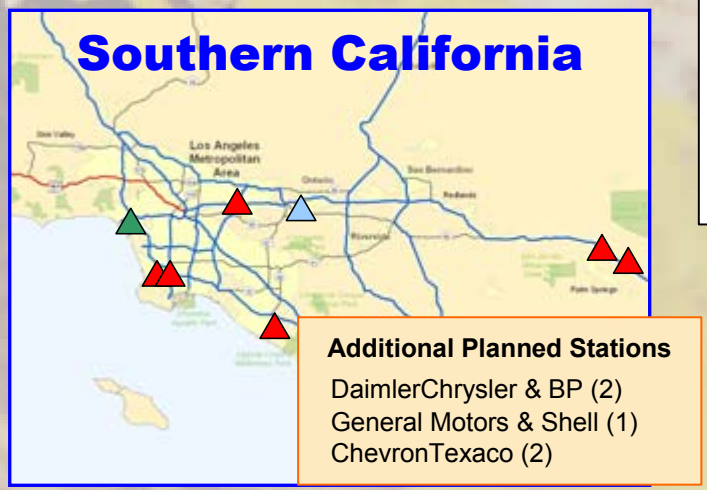
- 26 Fuel Cell Vehicles
  - -Ford Focus Vehicles (Gen 1)
  - -2 Fuel Cell Generations
- Up to 7 Fueling Stations
- 3 regions

Team Overview – GM



- 40 Fuel Cell Vehicles
  - -Opel Zafira Vehicles (Gen 1)
  - -2 Fuel Cell Generations
- Up to 7 Fueling Stations
- 4 regions

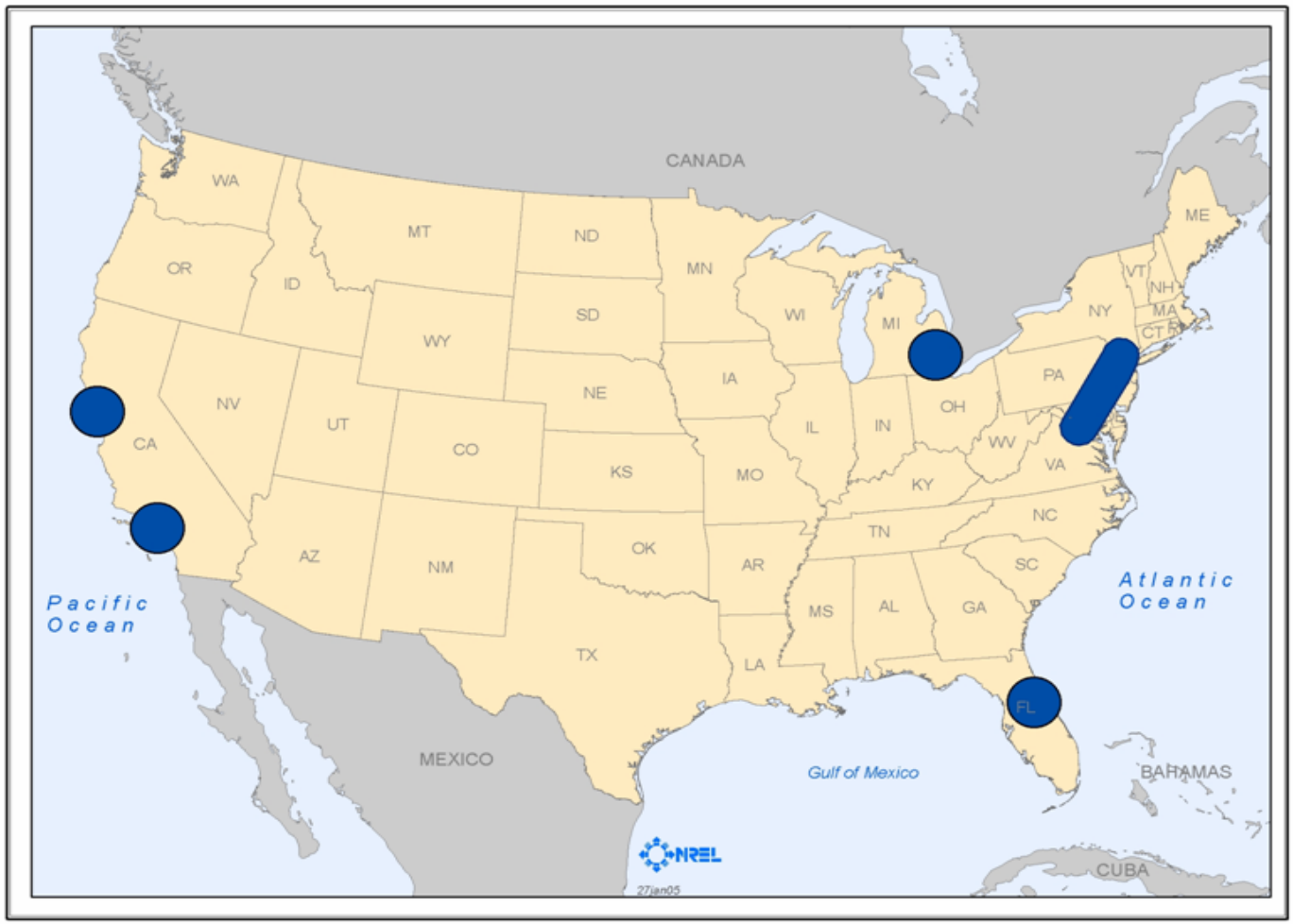
Refueling Stations from All Four Teams Begin to Create Regional Networks



Online Stations

- Ford & BP
- ChevronTexaco
- DaimlerChrysler & BP
- General Motors & Shell
- Other Companies

Data Collection: Diverse Geography Addresses Four Key U.S. Climates



Cold, Moderate, Hot/Humid, Hot/Arid Climates

Teams Will Field Four Main* Types of Vehicles

*DaimlerChrysler will also have FCV Sprinter vans

Sample Hydrogen Refueling Infrastructure

DTE/BP Power Park, Southfield, MI

LAX refueling station

Hydrogen and gasoline station, WA DC

Photo:Shell Hydrogen

Chino, CA

Photo: H2CarsBiz

Data Collection: Overview

Key Vehicle Data	Key Infrastructure Data
Stack Durability	Conversion Method
Fuel Economy (Dyno & On-Road) and Vehicle Range	Production Emissions
Fuel Cell System Efficiency	Maintenance, Safety Events
Maintenance, Safety Events	Hydrogen Purity/Impurities
Top Speed, Accel., Grade	Refueling Events, Rates
Max Pwr & Time at 40C	H_2 Production Cost
Freeze Start Ability (Time, Energy)	Conversion, Compression, Storage and Dispensing Efficiency
Continuous Voltage and Current (or Power) from Fuel Cell Stack, Motor/Generator, Battery & Key Auxiliaries: (Dyno & On-Road)	

Data Collection & Analysis Process

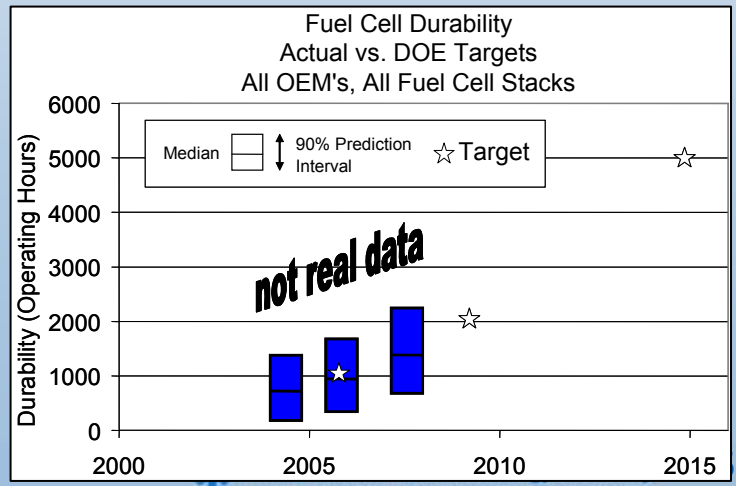
Raw Data, Reports

Hydrogen Secure Data Center (HSDC)

- @ NREL: Strictly Controlled Access
- Detailed Analyses, Data Products, Internal Reports
- HSDC ADVISOR

Composite Data Products

- Pre-Agreed Upon Aggregate Data Products
- No Confidential Information



Sample Composite Data Examples to Be Presented to Public Within Next 5 Years

A. Critical Program Metrics:

1. Fuel Cell Durability, Actual vs. DOE Targets, All OEM's
2. Vehicle Ranges, Actual vs. DOE Targets, All OEM's
3. H2 Production Cost, Actuals/Projections vs. DOE Targets

B. Composite Performance Tracking:

Vehicles

4. Reliability (FC System & Powertrain, MTBF)
5. Start Times vs. DOE Target
6. Fuel Economy: Dyno, On-Road
7. Normalized Vehicle Fuel Economy
8. Fuel Cell System Efficiency
9. Safety Incidents - Vehicle Operation
10. Weight % Hydrogen
11. Mass of Hydrogen per Liter
12. Vehicle Hydrogen Tank Cycle Life

Hydrogen Infrastructure

13. H2 Production Efficiency vs. Process
14. Combined Heat and Power (CHP) Efficiencies
15. H2 Production Cost vs. Process
16. H2 Purity vs. Production Process
17. Hydrogen Impurities - Range for Production Process A
18. Histogram: Refueling Rate
19. Average Maintenance Hours - Scheduled and Unscheduled

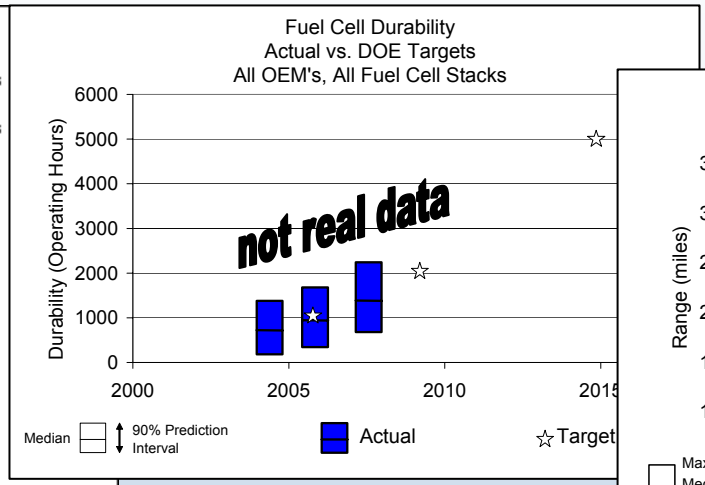
C. High Level Program Progress:

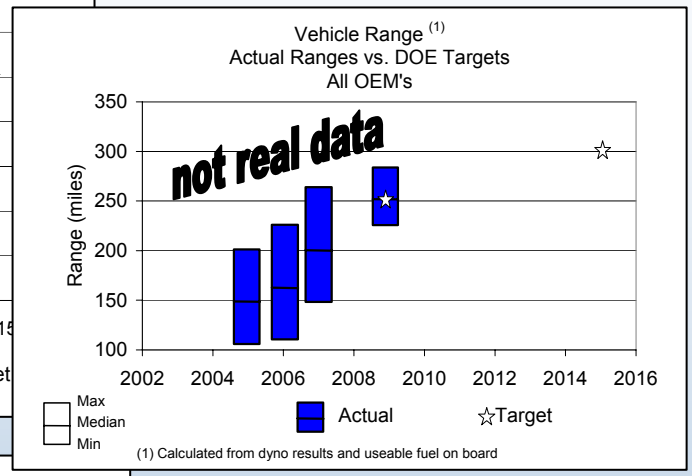
Vehicles

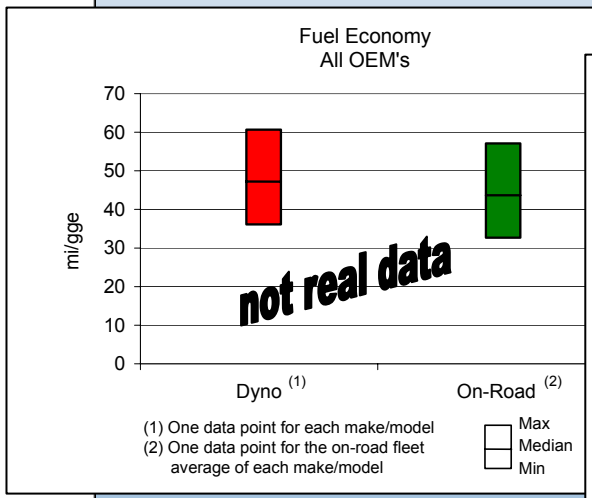
20. Range of Actual Ambient Temperatures During Vehicle Operation – All Vehicle Teams
21. Histogram: # Vehicles vs. Operating Hours to Date
22. Histogram: # Vehicles vs. Miles Traveled to Date
23. Cumulative Vehicle Miles Traveled - All Teams
24. Progression of Low to High Pressure On-board H2 Storage

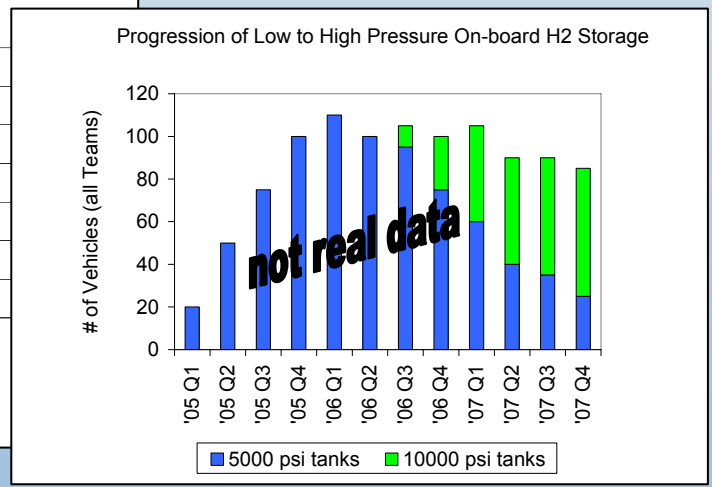
Hydrogen Infrastructure

25. Cumulative Hydrogen Production – All Teams







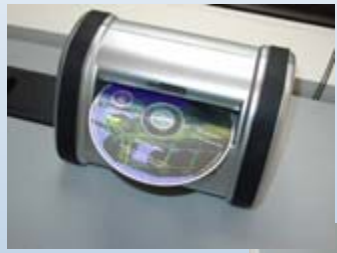


Handling Data Security at NREL

- Protects all raw data and our analysis results
- Only things that leave room:
  - composite data results
  - trend feedback into R&D

Server, workstation, tape backup and UPS

Two computer workstations



CD/DVD shredder

Motion sensors

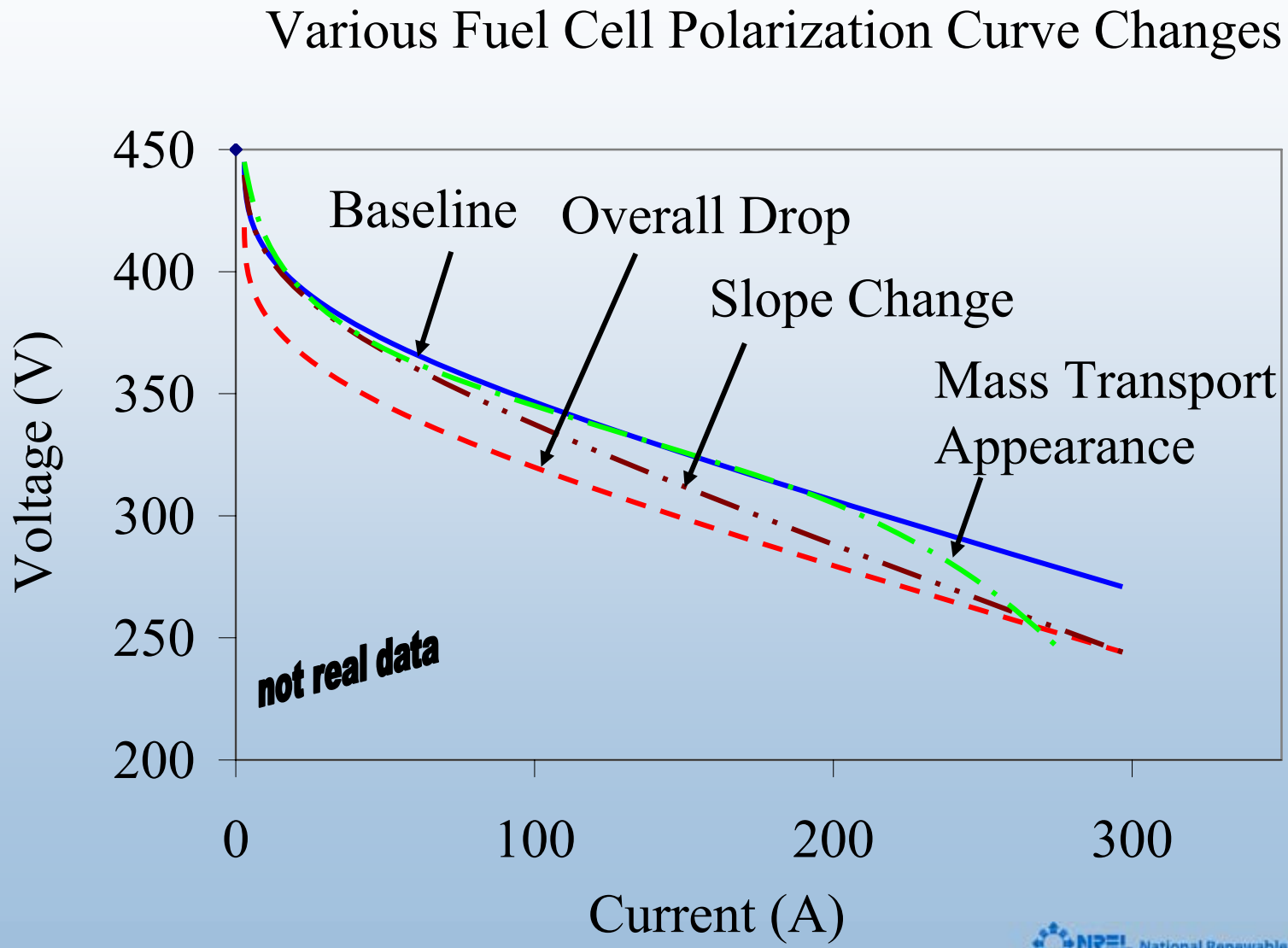
Audible alarm

PIN reader badge scanner

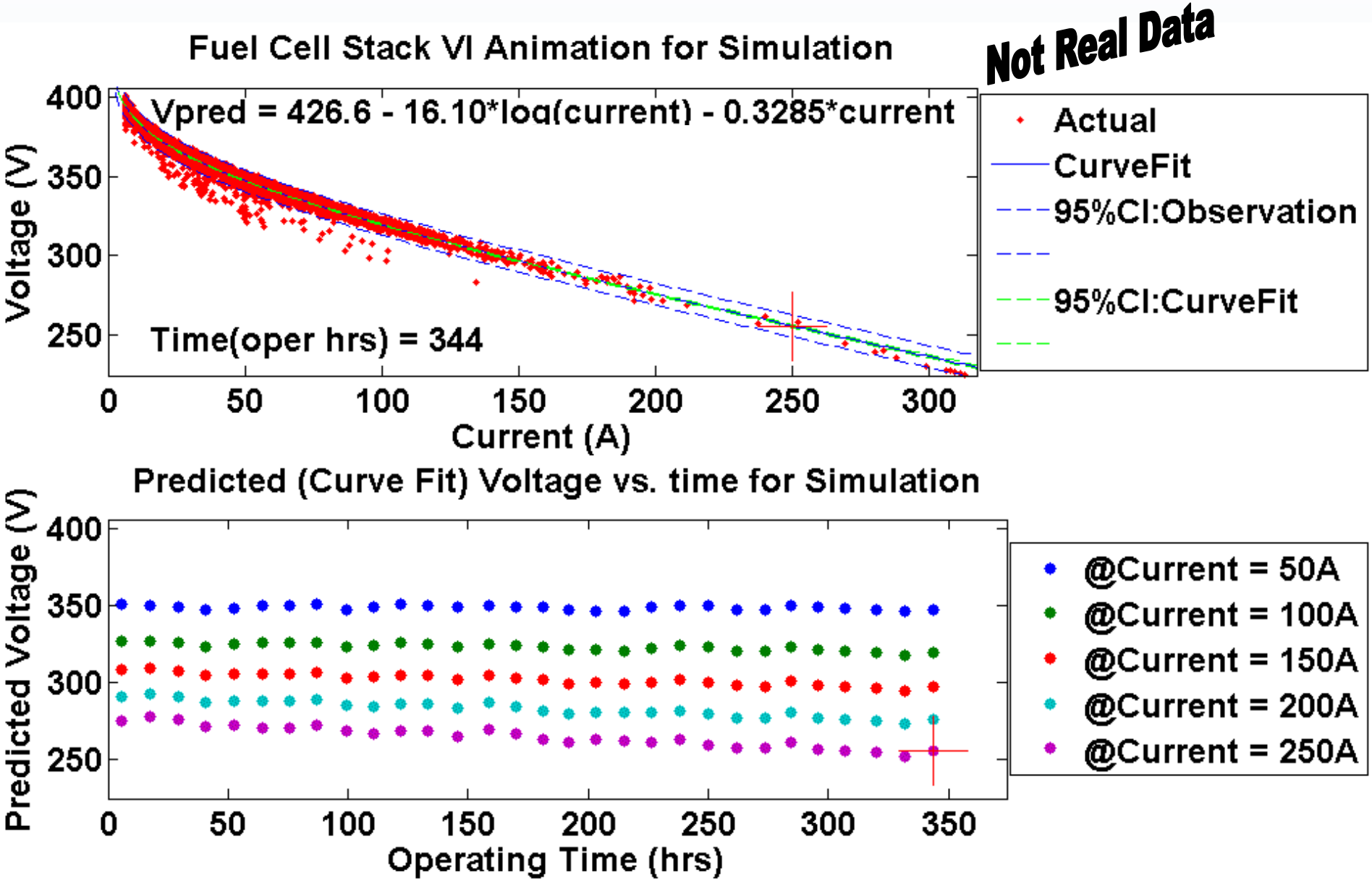
1350 lb. safe for backups

paper shredder

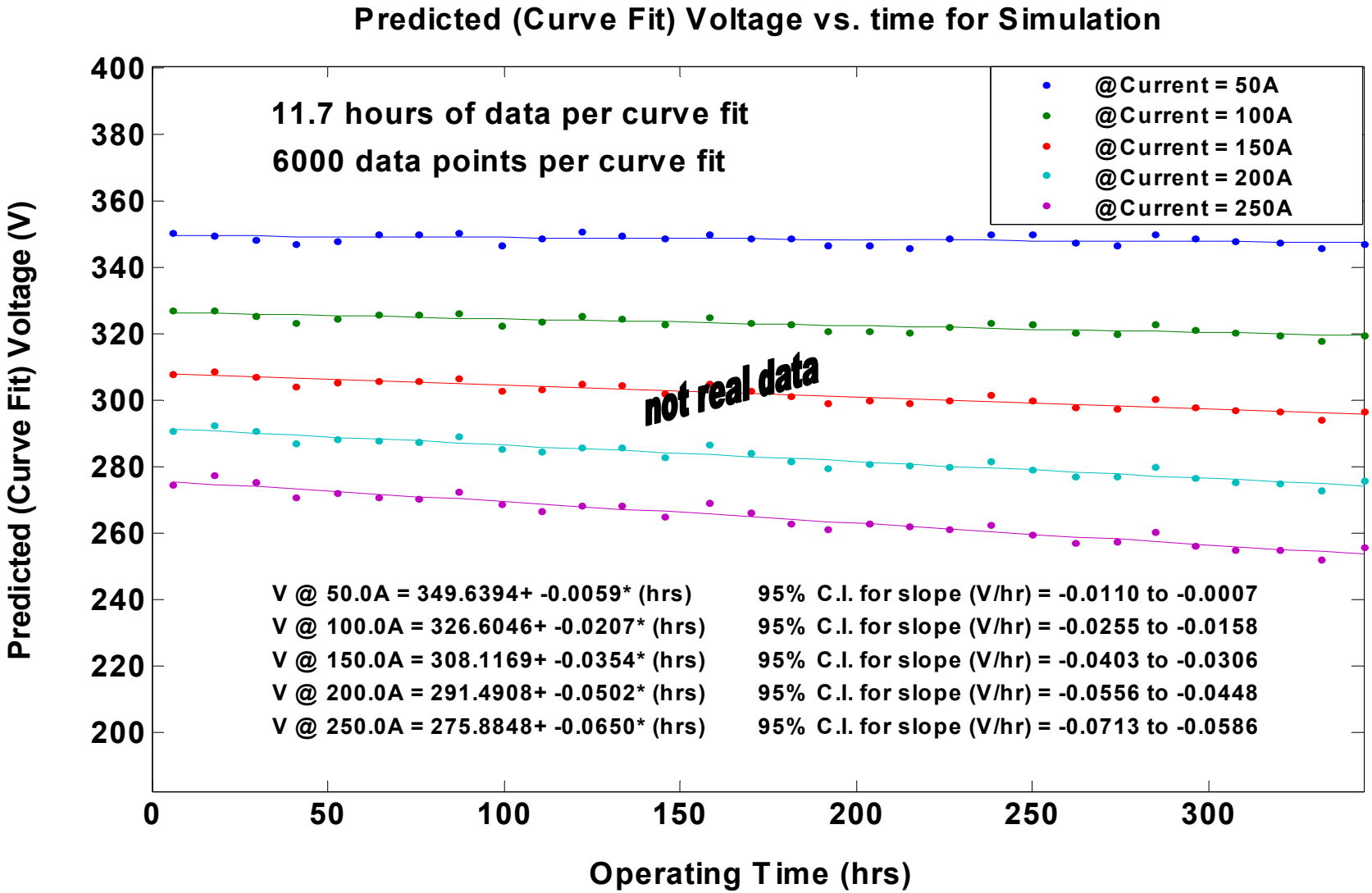
Analysis Example: FC Stack Degradation



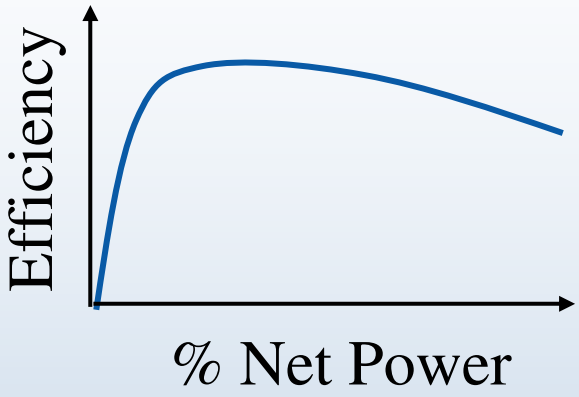
Analysis Example: Stack Degradation

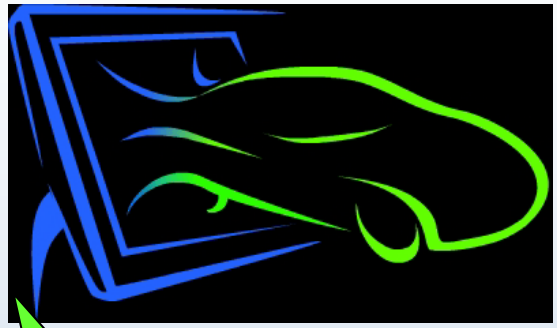


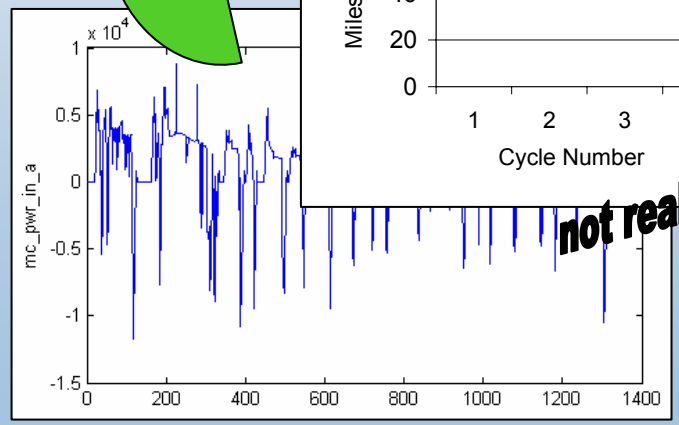
Analysis Example: Stack Degradation

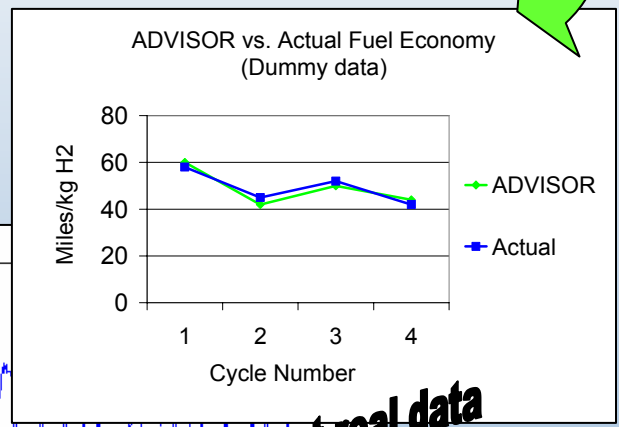


HSDC ADVISOR Will Assist in Trade-Off Studies and Refocusing R&D









not real data

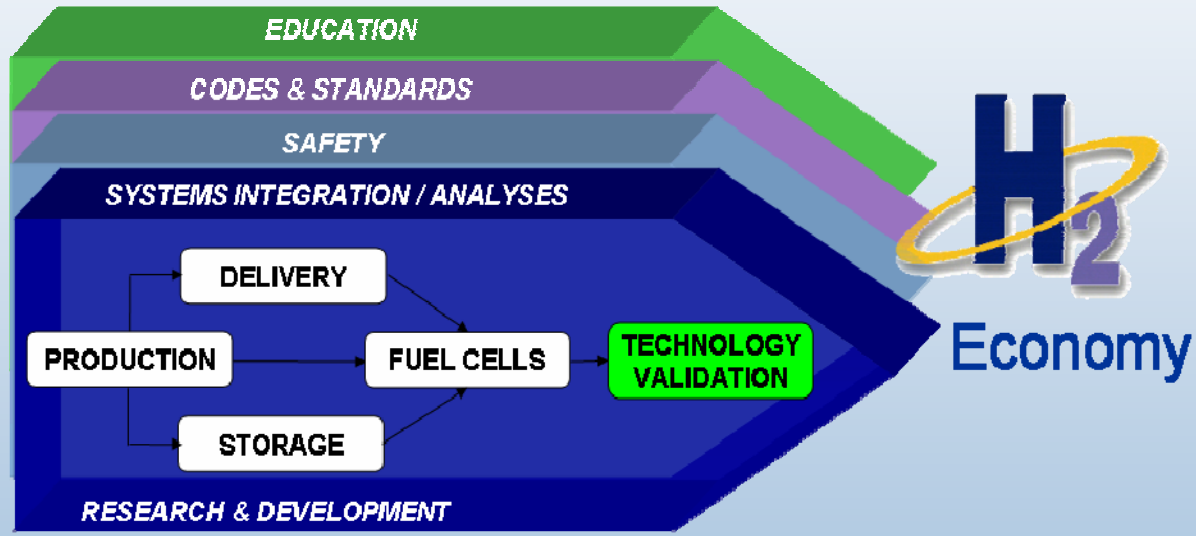
Vehicle, Power Plant Parameter Summary *Include parameters for each vehicle and power plant*	
Report Date	*insert report date*
Automaker	*insert automaker*
Parameter	**Units**
veh_CD (1)	dimensionless
veh_FA (1)	m2
Vehicle Mass (1)	kg
veh_front_wt_frac (1)	dimensionless
veh_cg_height (1)	m
veh_wheelbase (1)	m
Fuel Cell System	
c. Power Rating (net)	kW
Propulsion Battery or Capacitor	
c. Maximum Rated Ampere-Hour Capacity	Ampere*hrs
Electric Propulsion Motor	
b. Peak Power Rating	kW

Recent Activities – Opening of ChevronTexaco Station in Chino

Conclusions

- A data collection and management system has been implemented to provide critical information on:
  - Fuel cell lifetime, voltage degradation, and system efficiency
  - Vehicle range, fuel economy, and progress of H2 storage systems
  - Hydrogen production efficiencies and H2 purity
  - Refueling infrastructure performance
  - Other data to mark progress toward DOE technical targets
- Data will:
  - Help to identify status of technology
  - Re-Focus Research and Development
  - Support Commercialization Decision by 2015
- 25 key composite data products will be available to public
  - Show progress toward DOE/industry targets
- Data collection/reporting by partners has begun
- DOE coordination internationally through interagency programs and with state initiatives

Questions?



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